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Comparison of CRNAs with and without Supervision on Cost and Safety of Anesthesia

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Abstract

There has been controversy in the field of anesthesia regarding whether certified registered nurse anesthetists (CRNAs) or anesthesiologists provide safer and more cost-effective care. This study was done to compare CRNAs with and without supervision of an anesthesiologist and how it affects the cost and safety of anesthesia delivery. The results of this systematic review could provide information to affect policies regarding who is responsible for providing anesthesia, with safety and cost as the necessary variables. Twenty articles, published between the years 1999 and 2017, retrieved from the databases PubMed and Cinahl were analyzed and synthesized as part of this review. Studies that examined safety and cost effectiveness among CRNAs and anesthesiologists were included in this review. All but one article was from the US. Sample sizes in the studies ranged from 27 to over 1,000,000 participants ranging from patient chart reviews to surveys. Findings of this review showed that there was not enough evidence to conclude if CRNAs are more cost effective or provide better quality care alone or supervised.

Comparison of CRNAs with and without Supervision on Cost and Safety of Anesthesia

Money and safety are two important features in every aspect of society. This holds true in the business world and in the medical field. Changes are constantly being made in the way things are done to improve safety for patients and provide care at the lowest possible cost in every area of the medical field. These changes are often rooted in medicine, moving toward professionals who provide cost-effective high-quality care with safe outcomes. However, the answer to the following question still looms in the air. Will physicians remain the primary caregiver or will advanced practice nurses become more prevalent? One area of medicine where this idea is important is the operating room. According to the National Center for Health Statistics (2009), 48 million surgical inpatient surgical procedures are performed each year, necessitating the use of anesthesia for many patients. Determining the lowest cost of administering anesthesia in the safest way possible is important. Multiple factors influence the cost of surgery, including what healthcare professionals make up the anesthesia team.

The team could be a combination of three different professionals including: (1) certified registered nurse anesthetists (CRNA), a nurse with a masters or doctorate degree, (2) anesthesiologists, a physician, or (3), anesthesia assistants, an individual who also holds a master's degree from an accredited anesthesiologist assistant program. As with anything else, the different members of the team, with different qualifications, and educations have different pay scales. According to a study conducted by Hogan, Moore, Seifert, and Simonson (2010), otherwise known as The Lewin Group, anesthesiologists

make approximately two and a half times more money a year than CRNAs. Hogan et al. (2010), also found that interestingly, insurance companies pay the same amount for anesthesia services regardless of the medical professional acting as the anesthesia provider. The study conducted by the Hogan et al. (2010), concluded that the most cost-effective way of delivering anesthesia is a CRNA as the sole provider, which is a profound find in the evolving medical field.

In the United States, there are approximately 49,000 practicing CRNAs who administer around 40 million anesthetics per year with great patient outcomes regarding provider errors. (Quintana, 2016). Anesthesiologists also have great outcomes regarding these things listed above but come at more of a financial burden to the institution because of their salary. Anesthesia assistants are less prevalent than both the CRNA and anesthesiologist in the workforce regarding the total number employed. Part of this is because of the few numbers of schools that offer this program. Therefore, there are less studies about anesthesia assistants.

In 17 states, CRNAs have the authority to act and practice independently of a physician. That is because the states have chosen to “opt out.” “Opt out” is the terminology used to indicate that a CRNA can practice independently and does not need to practice under the direction of a physician. This decision is at the discretion of the governor and allows nurse anesthetists to provide anesthesia to the fullest scope of their abilities and education solely on their own without supervision or reimbursement requirements from a physician (Quintana, 2016). Despite there already being 17 states that have opted out, anesthesiologists show strong opposition to the idea of CRNAs working independently. Numerous anesthesiologists claim that more people will die as a

result of CRNAs not having the extensive medical knowledge that a doctor possesses (Izlar and Malina, 2014). There have been several studies conducted that evaluate cost and patient outcomes associated with CRNAs and anesthesiologists. This review will investigate the outcomes associated with patient care and cost when comparing anesthesia provided by CRNAs or anesthesiologists. The results of this systematic review could provide information to affect policies regarding who is responsible for providing anesthesia, with safety and cost as the necessary variables.

Methods

First, a PICO question was developed in order to narrow the area of study: How do CRNAs with and without supervision of an anesthesiologist affect cost and safety of anesthesia delivery? The PICO question was set in order to determine the impact on cost effectiveness and patient safety when comparing CRNAs working without physician supervision with CRNAs working with physician supervision. The information was obtained for this review by compiling data of previous studies and research projects that were conducted to determine specific information about anesthesia services. Two databases, Cinahl and PubMed, were used in order to find the information. In order to locate the articles, keywords were used such as: physician, supervision, nurse anesthetist, safety, quality, effectiveness, economic, and cost. Twenty articles were gathered and reviewed. Due to limited current research findings related to this topic, the time frame covered nearly 20 years, spanning from 1999 through 2017. A table of evidence was then compiled to sort the articles in order to analyze and synthesize the data (Appendix).

Safety and Quality of CRNAs Versus Physician Anesthesiologists

Patient safety has and will always be the most important aspect of health care (Ardizzon, Enlow, Evanina, Schnall, and Currie, 2009). Safety in terms of anesthesia can be defined as deaths related to anesthesia within 30 days of anesthesia delivery or a failure to rescue. This is further defined as the 30-day death rate in those who either had a complication develop, or who died without a complication (Silber et al, 2000). Of the 20 articles from our study, nine of those talked about the safety and quality of anesthesia delivered by a CRNA or an anesthesiologist/supervisor (Abenstein, Long, McGlinch, and Dietz, 2004; Dulisse and Cromwell, 2010; Hogan, Seifert, Moore, and Simonson, 2010; Needleman and Minnick, 2009; Pine, Holt, and Lou, 2003; Posner and Freund, 1999; Schreiber and MacDonald, 2008; Silber et al., 2000; Simonson, Ahern, and Hendryx, 2007). Hogan et al (2010), Dulisse and Cromwell (2010), Needleman and Minnick (2009) Pine et al (2003), Posner and Freund (1999), and Simonson et al (2007) claimed there was no difference in the quality of safety of the anesthesia given while Abenstein et al (2004), Scheiber and MacDonald (2008), and Silber et al (2000) said that supervision had a higher safety rate.

In the last quarter century, the number of anesthesiologists has tripled in size, whereas CRNAs have grown by 75%. The growth in this professional field, along with improved conditions of anesthesia, may be a contributing factor related to the improvement in anesthesia outcomes (Abenstein et al., 2004). Abenstein et al (2004), reviewed a variety of studies and health policy data. They found that the best patient outcomes were a result of anesthesiologists medically directing- and supervising-the CRNA. A limitation to this review was that no statistical analyses were given and therefore interpretation was limited (as cited in Abenstein et al., 2004). Abenstein et al.

(2004), also reviewed a research study done by Silber et al (2000). Silber et al (2000) and his team concluded that death, complications, and failure to rescue rates were higher when anesthesia was given without supervision by an anesthesiologist. These researchers reviewed all the Pennsylvania Medicare claim records in patients that were 65 years or older and received general or orthopedic procedures. Overall, Silber et al. (2000) reviewed 194,430 cases involving CRNAs acting under supervision and 23,010 cases utilizing CRNAs acting without supervision. Silber et al. (2000) defined supervision as those who were receiving medical direction from anesthesiologists, and no supervision as CRNAs who practice alone, or those who practice under a physician, or surgeon. Physicians and surgeons are included under the no supervision column because they have very basic, if any, knowledge about anesthesia (Schreiber and MacDonald, 2008). After adjusting for illness severity and hospital characteristics, Silber et al. (2000) found higher rates of mortality and failure to rescue among the non-directed group of CRNA's. Silber's results concluded that the 30-day mortality rate was 4.53%:3.41%, complication rate was 47.9%:41.2%, and failure to rescue rate was 9.32%:8.18% for CRNA's without supervision compared with CRNA's with supervision respectively. The CRNAs with supervision had lower rates in all three categories. One limitation to this study was that Silber and his team (2000) only looked at Pennsylvania Medicare claims. Another limitation is that the sample utilized consisted only of individuals 65 years of age or older. Additionally, the study was limited to surgeries performed in Pennsylvania, making it difficult to generalize to the rest of the country.

Hogan et al (2010) found different results than Silber et al. (2000) and Abenstein et al. (2004). Hogan et al. (2010) reviewed literature, health care claims, and patient

discharge data and concluded that there was no significant difference in complication rates between anesthesiologists and CRNA's. Limitations to their findings were that some researchers did not clearly state who the anesthesia was delivered by if an anesthesiologist was supervising. The anesthesiologist could have been supervising a CRNA or an anesthesiology resident. Hogan and his team (2010) also reviewed the Ingenix national database, which contains medical and financial claims. After reviewing 52,636 claims from the Ingenix National Database, they concluded that there were no complications that arose from anesthesia. Their findings overall found that the incidence of complications caused from anesthesia and mortality rates were very low and not statistically significant, but the rate was not given.

Dulisse and Cromwell (2010) found findings similar to Hogan et al. (2010) regarding patient safety and quality among unsupervised, practicing CRNA's. Dulisse and Cromwell (2010) examined patient outcomes resulting from anesthesia provided by an anesthesiologist compared with CRNA's in opt-out states and non-opt out states. They used Medicare Inpatient (part A) and carrier (Part B) Medicare claims between the years of 1999-2005. Dulisse and Cromwell (2010) excluded claims that included procedures being done in ambulatory centers because there was uncertainty when measuring mortality and complications in those cases. In addition, claims that did not include Medicare Part B were excluded since Medicare Part B was used to determine the provider for the anesthesia care. The seven-year span revealed 741,518 discharges, but about one-third did not have anesthesia billed because most likely none was required for those patients. After all the exclusions took place, 481,440 claims were up for review. The non-opt out states had 412,696 claims, while the opt-out states had 68,744

claims. Seven patient indicators were used to determine patient safety: (1) complications of anesthesia (2) death in low-mortality diagnosis; (3) failure to rescue; (4) iatrogenic pneumothorax, or collapsed lung; (5) postop physiologic and metabolic derangements or physical/chemical imbalances; (6) post-op respiratory failure, and (7) transfusion reaction. After gathering all the data and comparing it, Dulisse and Cromwell (2010) concluded that a general downward trend appeared in mortality rates, not only in anesthesiologists, but also in solo CRNAs. There was a slight increase in the mortality rate from 1999-2001, before the opt-out rule, but after the rule was in place, the CRNA with no supervision trend decreased from 2001-2005. Overall, from 1999-2005, CRNAs with no anesthesiologist involvement showed no increase in adverse outcomes in either opt-out or non-opt-out states. Solo anesthesiologists also showed no increase in adverse outcomes (Dulisse & Cromwell, 2010). Pine et al (2003) had a similar study done with Medicare Part A and B between 1995 and 1997 in 22 of the US states. They found that in the 404,194 cases analyzed, the risk mortality rates of CRNAs working alone (0.45%) and anesthesiologists working alone (0.41) were very similar.

Needleman and Minnick (2009) and Simonson et al (2007) both compared the anesthesia outcomes of cesarean sections when anesthesia was given by anesthesiologists only and CRNAs only. Needleman and Minnick (2009) conducted the research by giving a survey of obstetrical organizational resources and by getting information given by hospitals to state agencies. They collected data from 1999-2001 in California, Florida, New York, Washington, and Wisconsin, and data from 2000-2001 in Kentucky and Texas. Outcomes were coded from discharge data and anesthesia and other complications were coded based on the International Classification of Diseases, 9th

Revision, Clinical Manifestation (ICD-9-CM). Rates for each outcome were estimated for each anesthesia provider model. Selection of a hospital could have played a substantial role in women with high-risk pregnancies, which can have a higher associated risk of anesthetic complications, so a propensity analysis was performed to adjust the selection. Anesthesia complication rates in CRNA-only hospitals were at 0.23% while anesthesiologist-only hospitals were at 0.27%. After doing a multivariate analysis, no significant differences were found in anesthetic rates between the two hospital types, even though the initial rates showed CRNA-only hospitals had a lower complication rate. Mortality rates in the study were as follows: anesthesiologist-only hospitals had a 0.0089% rate while CRNA-only hospitals had a 0.0047 rate. While these are different, they are not statistically significant. Limitations to this study include that this was only a study about maternal outcomes. Many anesthetic related complications are shown in the health of the baby (Needleman and Minnick, 2009).

Simonson et al (2007) had similar findings when comparing CRNA-only hospitals to anesthesiologist-only hospitals when looking at obstetrical anesthesia services for cesarean sections (C-sections). They looked at the state of Washington's hospital discharge data between the years 1993 and 2004 for all C-sections. Surveys were completed by anesthesia providers or medical staff administrators at the hospital for the years 1999, 2002, and 2004. Data from a total of 68 hospitals were used in this study and were categorized according to the staffing represented for most of the year. ICD-9-CM codes for comorbidities were also used in this study and were important for developing a proper risk adjustment model. Overall, there were 134,806 patients used in this study. Of those, 33,236 were from CRNA-only hospitals, while 101,570 were from

anesthesiologist-only hospitals. Once the data was compared, CRNA-only hospitals had a complication rate of 0.58% while anesthesiologist-only hospitals had a 0.76% complication rate; this was before adjusting for comorbidities. After the adjustment, Simonson and his team (2007) found that there was no difference in anesthetic complication rates in hospitals who were staffed by anesthesiologists or CRNAs. Limitations to this study included that staffing patterns in the hospital were based off surveys to see if it was primarily anesthesiologist or CRNA. Another limitation was that this study was limited to the state of Washington and only to a subset of patients, so it may not be generalizable to other populations (Simonson et al, 2007).

Unlike the other studies reviewed, Posner and Freund (1999) claims that the quality of anesthesia care was not affected by changing anesthesia team composition, but he and his team only looked at the team model approach. CRNAs or anesthesiologists were not looked at individually. In this study, the researchers measured the monthly proportion of surgeries performed by anesthesiologists, attending residents, and attending CRNAs. At the University of Washington Medical Center, Posner et al (1999) gathered data from in the hospitals continuous quality improvement (CQI) program, where only adverse events and outcomes related to anesthesia management are recorded. Posner and his team (1999) also collected data from 83,452 cases in the years 1992 through 1997 from the Department of Anesthesiology clinical activity database because it consisted of the data from the anesthesia record and served as the recording mechanism for clinical activity from anesthesiologist, CRNAs, and residents. Overall, Posner et al (1999) concluded that indicators of the quality of anesthesia care did not appear to decrease. Nothing was stated about what the indicators of quality were in this study. Limitations to

this study were that it was only done at one teaching hospital, and the CRNAs without supervision were not looked at to see if there was a difference in quality and safety for the patient (Posner et al., 1999).

Cost Effectiveness

When synthesizing information about the delivery of anesthesia one very important aspect the cost of anesthesia in general and the comparison of the different providers. According to five different studies reviewed models or teams in which anesthesia can be administered. The different scenarios include an anesthesiologist working independently, a CRNA working independently or a combination of the two referred to as supervised or medical direction (Abenstein, Dietz, Long, & McGlinch, 2004; Cromwell & Snyder, 2000; Hogan, Moore, Seifert & Simonson, 2010, Hoyem, Jordan & Qurashi, 2017 Miller, Ohsfeldt, Scheibling & Schneider 2016). Regarding salary, physicians make more than CRNAs, \$224,000 \$80,000 respectively (Abenstein, Dietz, Long, McGlinch 2004 Cromwell 1999). However, other cost adverse events including patient death or injury, which takes a toll on the total cost of the healthcare system. Of the five articles, three best model of anesthesia administration the one made up of both an anesthesiologist and CRNA and referred to as medically directed (Cromwell Snyder, 2000 Hoyem, Jordan & Qurashi, 2017 Miller, Ohsfeldt, Scheibling & Schneider, 2016). Hogan, Moore, Seifert and Simonson (2010) stated that CRNAs all hands-on tasks the most cost effective because they perform everything an anesthesiologist but salaried. Abenstein, Dietz, Long, and McGlinch (2004), had similar findings to Hogan et al. (2010) in that they found that when other factors like adverse patient outcomes taken into consideration, physician anesthesia the lowest net healthcare

costs due to less cost for facilities less provider mistakes. Physicians had a lower overall net cost, despite their much larger salary. Glance (2001) by way of a study using a simulation approach to describe different appropriate care team models for different acuity of patients. He stated high risk patients should be managed by an anesthesiologist alone, while medium risk patients should be managed by an anesthesiologist to CRNA ratio of 1:2, and finally low risk patients should be managed by an anesthesiologist to CRNA ratio of 1:4. With regard to simple procedures, endoscopies fall under this category. Dumonceau (2010) stated that propofol, a drug used for conscious sedation in endoscopy procedures, if administered by a non-anesthesiologist could save 3.2 billion dollars over a 10-year period. This is another example of the difference in compensation for anesthesiologist versus other anesthesia professionals.

Hogan et al. (2010) found that anesthesia related mortality rates have declined substantially during the past two decades to one death per 240,000 anesthetics. With those odds determined, there were no significant differences in rates of anesthesia complications or mortality dependent upon the provider as being the anesthesiologist or CRNA. The researchers for this study evaluated different anesthesia delivery models, which were an anesthesiologist practicing independently, a CRNA practicing independently, or a team of the two working together. After the models were determined, a simulation was set up in order to determine the cost and effectiveness of care when different delivery models used. Salaries of the different professionals also played a role. The results to this simulation indicated that independent CRNAs the most cost effective. Supervised or medically directed CRNAs were second in cost effectiveness. The ratio of anesthesiologists to CRNAs varied based the risk or complexity of the case (surgery

being performed). Lastly, anesthesiologists cost the most. Limitations to this study included different hospitals utilizing different anesthesia delivery methods dependent upon the surgery performed. Therefore, the control of variables was not consistent among hospitals.

Differing from Hogan et al (2010), Miller, Ohsfeldt, Scheibling, and Schneider (2016) discovered that a team model was the most cost effective for anesthesia delivery. Miller et al. (2016) conducted a systematic review examining the cost effectiveness of CRNAs. The studies chosen for review used patients from ambulatory knee and shoulder surgery centers. According to Miller et al. (2016), the role of CRNAs has grown substantially over the last few years with many substituting for anesthesiologists. Findings related to finances emerged from this study, including the cost of unexpected patient dispositions or outcomes. Treatment costs for ambulatory procedures with anesthesia being administered by an anesthesiologist \$807, CRNA \$776, and a CRNA/anesthesiologist team \$750. Results of this review demonstrated less adverse events with an anesthesiologist present alongside the CRNA, lending the team model approach to be considered the more effective delivery model. Building on this, different team models are better for different settings but the least expensive taking everything into consideration is two CRNAs for every anesthesiologist (Cromwell & Snyder, 2000). limitation to this study that it does not consider injuries prior to surgery that could cause admission to the hospital after surgery. This stems from the idea of the overall healthcare cost not just the providers salary. If the patient must be admitted to the hospital because of a mistake made during surgery, then it costs the facility a lot of extra money. In other

words, it's not just the salary of the provider that costs the facility but, instead, a variety of factors that contribute to the overall net cost.

Similar to hospitals having different payment rates for procedures, anesthesia providers also have different payment rates for specific insurances. The biggest insurance that affects the rate is Medicare. Medicare part A and B affect this process. Medicare part A poses a challenge to CRNAs because they must work under the supervision of a physician in non-opt out states in order to receive reimbursement from the insurance company. This requirement is stricter than most state laws and has potentially driven a wedge between the two professions (Malina, 2014). Medicare B also plays a large role because it has its own fee schedule and billing modifiers. Hoyem, Jordan, and Quraishi (2017) conducted a study to evaluate billing and payment rates for Medicare Plan B. The research retrieved data from the Medicare B National Summary Data files 2000 2014. After the data was retrieved, billing modifiers were examined. Medicare has a set payment rate, which is usually less for the CRNA than the physician's annual or normal rate (Abenstein et al, Cromwell & Snyder 2000; Quraishi et al, 2017). Physicians have the option to be a Medicare-participating provider with a fixed rate for pay, or they can be a non-Medicare-participating provider and charge up to 109.25% of the Medicare rate (Abenstein, Long, McGlinch, & Dietz, 2004). Regardless of whether the provider is a CRNA or anesthesiologist, Medicare part B uses the same formula (anesthesia base units + anesthesia time units * conversion factor). Because of this formula and the differences in salary of the two different providers, the cost of the anesthesia services for facility. Currently the anesthesia providers comprising Medicare part B are 49.6% CRNAs and 48.3% anesthesiologist. CRNA usage has increased from

10.9% in 2000 to 21.7% in 2014 in procedures done under Medicare part B. The number of Medicare part B anesthesia services grew from 10,000,674 in 2000 to 15,123,395 in 2014, which is an increase of 3.1% in anesthesia services per year. Similarly, the cost per year for anesthesia services for Medicare rose from \$2,857,482,250 in 2000 to \$3,683,483,517 in 2014 for a 2.1% increase in charges per year. This shows the medical cost of anesthesia has decreased as the number of CRNAs being utilized has increased. The results of this study demonstrate that there are more CRNAs practicing and the overall cost has declined. According to Hoyem, Jordan & Quraishi, (2017) CRNAs should use their education and training to practice at the fullest of their abilities because they are the most cost effective. A limitation for this study is that it only looks at Medicare, when there are several other different forms of insurance reimbursement. Despite Medicare having an impact on a CRNA can work independently or not, the optout rule allowing a CRNA to work independently shows no improvement access to anesthesia for customers. A study conducted by Halzack, Miller, & Sun (2016) showed that over a three-year period the states that did not opt out of supervision showed more anesthesia procedures than the states who did opt out. Therefore, independent, unsupervised CRNAs did not improve access to anesthesia delivery.

There are many consistent and inconsistent findings thus far in this review regarding what anesthesia provider is more cost effective and provides higher quality and safer care. Some studies lean toward anesthesiologists while some lean toward CRNAs. With the limited research and, according to Alderson, Lewis, Nicholson, and Smith (2014) it is impossible to conclude which type of anesthesia provider is superior to the

other. Too many complexities and other factors play a role that prevents a definitive answer from being made at this time.

Critical Appraisal of Evidence

The review of literature compared 20 studies across the United States that spanned from 1999 through 2017. Research is limited on this topic due to different policies throughout hospitals and lack of research on this topic. Throughout the review of literature, it was discovered that even if a CRNA is in an opt out state, their ability to practice alone solely depends on the hospitals policy if a CRNA can practice alone. For future research it is important for studies to compare similar policies in similar hospitals, meaning compare opt-out state hospitals that allow CRNAs to practice alone with opt-out state hospitals that do not allow CRNAs to practice alone. Comparing to non-opt out state hospitals is also important to truly see if CRNAs are more cost effective and safe as anesthesiologists. It is also imperative to compare similar surgery types, so results are not skewed because of how critical the patient is. Research was gathered through databases and compared to similar studies found in both safety and cost effectiveness.

Safety. Across the nine studies involving safety, there were limitations within the research. During Silber et al (2000) research, only studies were done on patients in Pennsylvania over the age of 65 who had Medicare. Although he and his team compared like hospitals and severity of the illnesses, it is hard to generalize results formed from that research across the country because it was only conducted in Pennsylvania and on Medicare clients Silber et al, 2000). Research also conducted among Hogan et al (2010) found limitations because the person who was delivering the anesthesia was not clearly stated. Although it was stated that there was no significant difference in complications,

not having a clearly stated mode of administration can skew results in either way because it is unknown if complications arose from lack of supervision, or while supervision was happening (Hogan et al, 2010). In Dulisse and Cromwell's (2010) study and Pine et al (2003) research, both compared Medicare Part A and B claims across opt out and non-opt out states. Their research concluded that there is no difference in either state when comparing safety and quality of anesthesia by CRNAs alone. By comparing in both opt out and non-opt out states, it gives a better conclusion than just comparing results from one state (Dulisse & Cromwell, 2010; Pine et al, 2003). Posner and Freund (1999) compared data from one teaching hospital and looked at the composition of the anesthesia team, but anesthesiologists and CRNAs were not looked at individually. Limitations to this study included not comparing safety rates of solo CRNAs and CRNAs under supervision (Posner et al, 1999).

Both Needleman and Minnick (2009) and Simonson et al (2007) compared safety of anesthesia delivery in cesarean sections and both found that rates in complications were similar for CRNAs and anesthesiologists. In Needleman and Minnick's (2009) study, they compared rates of complications amongst various states and similar hospital styles, so no high-risk pregnancy patients skewed results. Limitations in their studies were only looking at maternal outcomes post-anesthesia. Most complications derived from anesthesia affect the baby and its health (Needleman and Minnick, 2009). In Simonson et al's (2007) research, complications were only looked at in Washington state and were collected through surveys given to staff. Limitations included only being in Washington state and only looking at a subset of patients, so it is hard to generalize conclusions (Simonson et al, 2007).

Cost Effectiveness. The remaining studies involved cost effectiveness and whether CRNAs are considered more cost effective than anesthesiologists. Abenstein et al (2004), Cromwell et al (2000), Hogan et al (2010), Hoyem et al (2017), and Miller et al (2016) all defined in their research if it was a CRNA practicing on their own or if they were under the supervision of the anesthesiologist. Comparing rates of cost effectiveness was also determined by the type of surgery being performed. Limitations arose from this concept because hospitals use different anesthesia delivery models based on how critical the surgery was (Hogan et al, 2010). In a study done by Miller et al (2016), they compared patients in ambulatory knee and shoulder surgery centers. This study concluded that CRNAs supervised by anesthesiologists was the most cost-effective delivery model. Limitations to this study include not having knowledge of other injuries that occurred to patients prior to coming in for surgery. Complications that could have arose may have been from anesthesia, which would cost the surgery center money contributing to the overall cost effectiveness, or they could have happened from previous injuries sustained.

Insurance can also play a part in determining cost effectiveness, especially Medicare Part A and B. Hospitals that get reimbursement through Medicare Part A must have CRNAs working under supervision of an anesthesiologist, thereby limiting the cost effectiveness comparison between solo CRNAs and anesthesiologists (Malina, 2014). Hoyem and his team (2017) looked through data comparing Medicare Part B because it has a different set of billing modifiers than Part A. By looking at Part B billing, it can compare cost of CRNAs and anesthesiologists making the results more prominent.

Limitations in this study including not including other insurance reimbursement types to conclude if CRNAs are more cost effective (Hoyem et al, 2017).

Synthesis of Evidence-

Medicine, whether from a medical or nursing perspective, evolves very quickly with new advancements, technology, and policy. One area in which change, and evolution is taking place is that of advanced practice nurses and their scope of practice. For this review, anesthesia was examined more closely. In terms of anesthesia there are three different providers with that being a CRNA, an anesthesia assistant, or an anesthesiologist. All three professionals are providers, however for the purpose of this review two of the three, CRNAs and anesthesiologists, were focused on. With that focus, the purpose of this review was to determine who provided the safest most cost-effective care of anesthesia services. With that information, one could then delve into determining whether a CRNA was capable of being a sole provider of anesthesia without supervision from a medically prepared physician. The current state of this discussion comes down to the fact of if a CRNA can practice with the same effectiveness and safety of an anesthesiologist but is two and half times cheaper, despite what insurance companies pay, why couldn't they practice independently (Hogan et al. 2010)? Also reported by Hogan, mortality among anesthesia has significantly decreased in the last two decades regardless of the provider. This information says something if the number of practicing CRNA's has drastically increased in the last two decades as well. In fact, that is the case in some "opt out" states, 17, where CRNAs are granted the right to practice solely independent (Quintana, 2016). However, even with that right, different hospitals have different policies that affect how anesthesia providers can practice and what they can do

independently and with supervision in their scope of practice. Despite, the debate at hand and the hold up with legislation and policy, CRNA's still practice with a high level of autonomy and responsibility. With changing health care, it will be important to reduce patient and insurance company expenses, therefore it will be important to decide the national benchmark level for a CRNA's scope of practice.

Due to the fact of different states and hospitals having different policies as far as the scope of practice for a CRNA, it would be helpful for health care as well as legislation within the government to be on a more similar stance with the idea of who is providing anesthesia in the operating room. By everyone being on the same page, more research can be done to truly find the best answer for who provides that best care at the lowest cost, while still putting the biggest emphasis on patient outcomes. The studies used in this review were from a broad time period due to their being limited research done on this topic in the last twenty years. Within that broad time period there were a lot of differing opinions about what the correct way of delivering anesthesia should be with limitations and barriers to the research. A lot of the progress and change is being slowed because of the medical providers opinion on the competency of CRNA's to practice independently. However, if evidence and research points toward CRNA's as being the cheapest providers with adequate patient safety outcomes, policy on both the state and individual hospital level is holding back progress. This progress will only make healthcare more accessible and affordable to individuals. Due to efficiency, effectiveness, and overall cost being a large priority, more and more research is being done in order to provide the most accessible anesthesia services to the public at the safest and lowest cost.

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